HIGHER ORDER ABERRATIONS DO NOT INCREASE WITH AGE

MARINE GOBBE
WAVEFRONT CONGRESS - ATHENS – 13/02/05
INTRODUCTION

Studies to date

Aberrations measured at FIXED pupil sizes for all ages

Higher order aberrations increase with age

PUPIL SIZE DECREASES WITH AGE
INTRODUCTION

Aim of correcting higher order aberrations
Improving visual performance

Aberrations measurements need to relate to the ocular optical system, and incorporate the effect of the pupil
INTRODUCTION

PURPOSE

Measure higher order aberrations for INDIVIDUALLY MEASURED PUPIL SIZES at relevant luminance

HYPOTHESIS

Higher order aberrations do not increase with age when pupil size is taken into account
METHODS - Population

N= 424 Eyes

No ocular abnormalities
Spectacles or soft contact lens wearers

FIVE AGE GROUPS:

<table>
<thead>
<tr>
<th>AGE (years)</th>
<th>N=</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-25</td>
<td>84</td>
<td>19.8</td>
</tr>
<tr>
<td>26-35</td>
<td>116</td>
<td>27.4</td>
</tr>
<tr>
<td>36-45</td>
<td>70</td>
<td>16.5</td>
</tr>
<tr>
<td>46-55</td>
<td>80</td>
<td>18.9</td>
</tr>
<tr>
<td>&gt;55</td>
<td>74</td>
<td>17.5</td>
</tr>
</tbody>
</table>
METHODS - Technique

Pupillometry  
(Infra-red pupillometer)

Videoaberroscopy  
(COAS)

Ocular Aberrations

MEASUREMENT FOR 3 FIXED LIGHTING LEVELS

- 250 cd/m²  High Luminance
- 50 cd/m²   Medium Luminance
- 2.5 cd/m²  Low Luminance

MEASUREMENT FOR 3 FIXED PUPIL SIZES

- 3mm
- 4.5mm
- 6mm
METHODS
Ocular Aberrations Parameters

Zernike Coefficients
\( W(x,y) \)

Pupil function
\( P(x,y) \)

Fourier Transforms
MATLAB

RMS
Pupil plane

Strehl ratio

Modulation Transfer Function
Retinal plane
## RESULTS – PUPIL SIZE (mm)

<table>
<thead>
<tr>
<th>Age groups (years)</th>
<th>18-25</th>
<th>26-35</th>
<th>36-45</th>
<th>46-55</th>
<th>&gt;55</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Luminance</td>
<td>2.96</td>
<td>2.73</td>
<td>2.70</td>
<td>2.67</td>
<td>2.57</td>
</tr>
<tr>
<td>Medium Luminance</td>
<td>3.93</td>
<td>3.49</td>
<td>3.52</td>
<td>3.31</td>
<td>3.22</td>
</tr>
<tr>
<td>Low Luminance</td>
<td>6.63</td>
<td>5.77</td>
<td>5.79</td>
<td>5.38</td>
<td>5.02</td>
</tr>
</tbody>
</table>

- 0.39mm difference at high luminance, and 1.61mm difference at low luminance

- 39.7% of the population had a pupil $\geq$ 6mm

**TRUE LOW LUMINANCE PUPIL VS 6MM FIXED PUPIL**
RESULTS – STREHL RATIO

No difference between age groups at low luminance (p=0.696)

18-25: less aberrations than any other age groups (p<0.001)
26-35: less aberrations than the over 46 years old (p<0.001)
No difference between age groups at low luminance (p=0.254)

18-25: less aberrations than any other age groups (p<0.001)
26-35: less aberrations than the over 46 years old (p<0.001)
RESULTS – MTF RATIO

No difference between age groups at low luminance (p=0.637)

18-25: less aberrations than any other age groups (p<0.001)
26-35: less aberrations than the over 46 years old (p<0.001)
RESULTS – RMS values (\[\text{mm}\])

No difference between age groups at low luminance (p=0.728)

18-25: less aberrations than over 36 years old groups (p<0.001)
Over-estimate HOA for >55, Under-estimate HOA for 18-25 for 6mm
CONCLUSION

For fixed pupil
Increase of aberrations with age

For real low luminance pupil
No difference in aberrations with age

IMPORTANCE OF MEASURING ABERRATIONS FOR INDIVIDUAL PUPIL SIZE
CONCLUSION

Senile myosis compensates for the deterioration of the optical quality of the eye with age.
CLINICAL IMPLICATIONS

USE OF 6mm pupil

Poor predictor of aberrations for night time vision

LOW LUMINANCE (night driving)

28.5% of the population had pupil diameter ≤ 5mm

12.2% of the population had pupil diameter ≥ 7mm
THANK YOU FOR YOUR ATTENTION